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Comparing Patterns in Antimicrobial Use During Global Point Prevalence Study at a Single Tertiary Hospital in Ghana: Implications for Antimicrobial Stewardship Programme

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Background: The Global Point Prevalence Study (PPS) provides a platform for institutions to register and add clinical information on antimicrobial usage and determine variables related to proper antimicrobial stewardship.

Objective: To assess the trends in antimicrobial usage and quality indicators in antimicrobial prescriptions at our hospital.

Method: We retrospectively compared data collected at Komfo Anokye Teaching Hospital (KATH) during the Global PPS in 2015 and 2019. Both surveys took place on a day in September of the respective year. Medical records of all in-patients on admission at 0800 hours on a specific day were reviewed for antimicrobial use in the survey. Data on antibiotic use, including indications for use and the presence of quality indicators, were recorded.

Results: The total number of patients on admission in 2015 and 2019 were 386 and 630, respectively. The proportion of patients on at least one antimicrobial was 64% (247/386) and 58.4% (368/630) in 2015 and 2019, respectively. Pneumonia was the most common medical condition for which antimicrobial was prescribed for 2015, 30(16.9%) and 2019, 44(23.0%), respectively. There was a decrease in Hospital-acquired infections from 2015, 6.2% (24/386) to 4.8% (30/630) in 2019. The use of biomarkers increased from 4.9% (12/247) to 7.6% (28/368).

Conclusion: Over 50% of hospitalised patients were on antimicrobials for both years. The inauguration of the antimicrobial stewardship committee at KATH will improve these quality indicators.

Keywords: comparison, antimicrobial, stewardship, global study, tertiary, WHO AWaRe Classification

INTRODUCTION

The Global Point Prevalence Survey (Global-PPS) on antimicrobial consumption and resistance provides institutions with clinical information on antimicrobial usage and quality indicators on appropriate antimicrobial prescribing.

The platform has allowed individual institutions to benchmark their antimicrobial use with merged results for the country, their region and Europe.

The irrational use of antimicrobials and lack of development of new drug molecules have precipitated microorganisms' antimicrobial resistance (AMR) (1). Therefore, to tackle this rise in AMR, the World Health Organization (WHO) advocates the adoption of antimicrobial stewardship by healthcare providers to monitor and reduce the burden of AMR (2). It is important to note that the unavailability of antibiotics in a country can also play a role in appropriate prescribing behaviour (3).

Using antimicrobials at the right time, for the proper purpose, and at the appropriate doses reduces mortality and morbidity. Antimicrobials have been widely abused for viral conditions such as covid19 and respiratory viral infections, marked by seasonal changes (4).

The decision to give antimicrobial is often clinical, but the willingness to stop after more evidence against their use is lacking. Factors influencing the prescribing of antimicrobials include clinicians' personal experience with medications, evidence-based scientific publication, recent influence by pharmaceutical presentation, and locally or internationally validated antimicrobial sensitivity patterns (5).

Biomarkers to determine when to start or stop antimicrobial is increasingly relevant in countries where poorly regulated drug authorities make it easy for anyone to get prescription-only medications at pharmacy shops without proper authorisation. Some patients reporting to the health facility might have had access to multiple medications over-the-counter (OTC). Similarly, patients reporting to community facilities are prescribed antimicrobials without prior investigations. When expected responses are suboptimal, patients are referred to a higher level where clinicians are in a dilemma on what to do next without some baseline investigations. When investigations for cultures are done after prior antimicrobials use, it negatively affects the microbiological yield.

The affordability and availability of biomarkers make it difficult for those in need to benefit. Biomarkers such as procalcitonin and C-reactive proteins, vital biomarkers for infections, cost 50-60 dollars per test in Ghana. With an average daily minimum wage of 2 dollars, most patients cannot afford it (6). There are instances where families' ability to mobilise resources delays getting the test done. This situation drives clinicians to prescribe second-and third-line antimicrobials blindly. Aside from adding to cost, there is also prolonged hospital stay, exposure to healthcare-associated infections and adverse effects of medication.

Before the introduction of antimicrobial stewardship, Komfo Anokye Teaching Hospital (KATH), with the child health directorate, had participated in the "Antibiotic Resistance and Prescribing in European Children Point Prevalence Survey" (ARPEC-PPS) (7). Next, two full-hospital Global-PPS were conducted in 2015 (8) and 2019. This study aimed to review the trends in hospital-wide antimicrobial usage and quality indicators on antimicrobial prescribing habits, using survey data collected in 2015 and 2019 at KATH.

METHODOLOGY

Study Setting

The studies took place at Komfo Anokye Teaching hospital (KATH). KATH is a 1,200 bed-capacity hospital located in the Ashanti Region of Ghana. It is a tertiary health care facility serving Ghana's middle and northern zones.

Komfo Anokye Teaching Hospital took part in the Global-PPS in 2015 and 2019, involving the whole hospital, including all adults, children and neonates.

Study Procedure

The Global-PPS protocol and paper data collection templates were freely available at www.global-pps.com. Both surveys took place on a day in September of the respective year. All in-patients occupying a bed at 8 am on the survey day were included. They were counted at ward level and served as denominators noted down on the ward paper form. Medical records of patients admitted to the ward and on antimicrobials at 8 am on the survey day were extracted and recorded on the patient paper form. Variables in this study included gender, age, type of antimicrobial, route of administration, reasons for use, presence of active community- or healthcare-associated infections (HAI) versus prophylactic prescribing, and results of routine microbiology tests performed. According to the Global-PPS protocol, HAI were defined as infections whereby symptoms started 48 hours after admission to the hospital. Variables included further a set of antimicrobial quality indicators such as whether the reason for the prescription and a stop/review date was written in the patient notes, whether local antibiotic prescribing guidelines existed, and compliance with these guidelines. Full details of the methodology employed are available elsewhere (8).

KATH has log-in details for accessing the Global-PPS web-based data entry repository. Information was then entered in a freely available web-based Global-PPS tool designed explicitly for data entry, validation and reporting and available from www.global-pps.com.

Data Analysis and Statistics

After extracting the data in Excel from the Global-PPS web-based data repository for KATH during the 2015 and 2019 surveys, variables of interest for the respective years were analysed.

Variables were represented as absolute numbers using Pivot Tables in Excel 2010 and percentages of total numbers of patients on antibiotics in respective years.

Ethical Approval

The study received approval from Komfo Anokye Teaching Hospital Institutional review board (IRB) number CHRPE/AP/523/19.

RESULTS

The total number of patients on admission in 2015 and 2019 on the survey day were 386 and 630, respectively. The proportion of patients on at least one antimicrobial was 64% (247/386) and 58.4% (368/630) in 2015 and 2019.

Table 1 shows the Directorate's data on bedspace, admissions, and antimicrobial uses during the 2015 and 2019 surveys. Aside from the neonatal unit, there was an increase in bedspace, patients admissions, and patients treated with antimicrobials in all other directorates. Whilst the children's wards saw an increase in antimicrobial use, there was a downwards trend in the other directorates between the two surveys. The neonatal medical unit had the highest antimicrobial use, 68.4%.

Table 2 shows the distribution of the top ten (10) medical conditions for which antimicrobials were prescribed in 2015 and 2019 at KATH. Pneumonia was the most common medical condition for which antimicrobial was prescribed in 2015, 30 (16.9%) and 2019, 44 (23.0%), respectively. Tuberculosis was the seventh and third medical condition with prescribed antimicrobial in 2015 and 2019. HIV was not amongst the top ten (10) in the 2015 survey.

Of all antimicrobials prescribed in 2015 and 2019 at KATH, 81.0% and 88.1% were antibacterials for systemic use. Amongst all antibacterials for systemic use, other beta-lactams remain the commonest antibiotics prescribed during both study years (40.6% and 36.8%, respectively), represented by the 2nd generation cephalosporin cefuroxime and the 3rd generation cephalosporin ceftriaxone. Quinolones (mainly ciprofloxacin) represented 8.1% and 10.8% in 2015 and 2019. Also, parenteral metronidazole was frequently prescribed (18.6% and 15.1%, respectively), mostly combined with another antibacterial for systemic use (**Tables 3**, **4**). The ratio of Access/Watch prescribing antibiotics (J01) remained the same over time (47% access versus 53% Watch antibiotics).

Table 5 shows the quality indicators for antimicrobial prescriptions. Most of the parameters improved from 2015 to

TABLE 1 | Comparing Directorates data on bedspace, admissions, and antimicrobial uses during the 2015 and 2019 survey.

		Bed space		N on admission		N on antimicrobial		% On treatment	
		2015	2019	2015	2019	2015	2019	2015	2019
MEDICAL									
Adult		180	244	86	152	66	83	76.7	54.6
Children	Paediatric	81	86	53	74	29	47	54.7	63.5
	neonates	107	95	91	76	59	52	64.8	68.4
SURGICAL									
Adult	Surgery	233	303	91	172	61	98	67.0	56.9
	Obstetrics	34	151	23	92	23	50	100.0	54.3
Paediatric ICU		48	50	42	25	9	14	21.4	56.0
Adult	Medicine	–	12	–	9	–	5	–	55.5
	Surgery	–	10	–	4	–	2	–	50.0
	Obstetrics	–	4	–	3	–	2	–	66.7
children	Paediatric	–	4	–	2	–	1	–	50.0
	neonates	–	24	–	21	–	14	–	66.7
TOTAL		683*	983*	386*	630*	247*	368*	64.0**	58.4**

*N, number; %, percentage; * absolute numbers; **average; ICU, intensive care unit.*

TABLE 2 | Top ten (10) in-hospital medical conditions treated with antimicrobials during the 2015 and 2019 survey.

KATH 2015		KATH 2019	
Medical conditions	**n %**	**Medical conditions**	**n %**
Pneumonia	30 (16.9)	Pneumonia	44 (23.0)
Skin and soft tissue	27 (15.2)	Skin and soft tissue	30 (15.7)
Obstetric/gynaecological infections	19 (10.7)	Tuberculosis	17 (8.9)
Bone/joint infections	14 (7.9)	lower urinary tract infection	15 (7.9)
Sepsis	13 (7.3)	Sepsis	13 (6.8)
lower urinary tract infection	12 (6.7)	HIV	11 (5.8)
Tuberculosis	11 (6.2)	Infection of the central nervous system	10 (5.2)
Intra–abdominal sepsis	10 (5.6)	Gastrointestinal infections	9 (4.7)
Infection of the central nervous system	9 (5.1)	Obstetric/gynaecological infections	7 (3.7)
Ear, nose and throat infections	8 (4.5)	Malaria	6 (3.1)

n=individual contributions; %=percentages.

Count on the number of diagnoses treated with at least one antimicrobial. This implies that a patient with multiple diagnoses can be counted several times. Prophylactic prescribing and patients admitted to NICU or NMW are excluded from this analysis.

TABLE 3 | Overview of antimicrobials prescribed by antimicrobial therapeutic subgroup in 2015 and 2019.

Antimicrobial types	2015 N (%)	2019 N (%)
Intestinal anti-infectives	**3 (70.4)**	**2 (0.3)**
Antibacterials for systemic use	**345 (81.0)**	**555 (88.1)**
Tetracyclines	1 (0.3)	2 (0.4)
Penicillins	45 (13.0)	69 (12.4)
Other beta-lactams	140 (40.6)	204 (36.8)
Sulfonamides and trimethoprim	6 (1.7)	18 (3.2)
Macrolides	43 (12.5)	60 (10.8)
aminoglycosides	17 (4.9)	55 (9.9)
Quinolones	28 (8.1)	60 (10.8)
Combinations of antibacterials	1 (0.3)	0 (0.0)
Other antibacterials	64 (18.6)	87 (15.7)
Antimycotics for systemic use	**1 (0.2)**	**1 (0.2)**
Antimicrobials	**44 (10.3)**	**17 (2.7)**
Antivirals for systemic use	**0 (0.0)**	**14 (2.2)**
Nitroimidazole derivatives	**33 (7,7)**	**35 (5.6)**
antimalarials	**0 (0.0)**	**6 (1.0)**
Total prescriptions	426	630

N, total number of antimicrobials prescribed; %, percentages.
The bold values represent main antimicrobial types. The regular font represents specific examples under the main types.

2019. We also observed a decrease in Hospital-acquired infections from 2015, 6.2% (24/386) to 4.8% (30/630) in 2019. Biomarkers in supporting diagnosis increased from 4.9% (12/247) to 7.6% (28/368). Data on cultures, sensitivity or resistance results were not available for extraction.

DISCUSSION

This study reviewed antimicrobial usage and quality indicators in a single tertiary care facility during two different time points, 2015 and 2019.

Komfo Anokye Teaching hospital had seen a significant expansion between 2015 and 2019, as observed by the increase in bedspace between the two surveys (from 683 to 983). The estimated bed capacity of the hospital, however, is around 1,200. There was also a difference in the supply of ward specialities. Intensive care (ICU) beds were only included in the 2019 survey because ICU beds were not yet available in the hospital in 2015. The bedspace for the neonatal medical unit was reduced in 2019 because space was created out of the total medical bedspace for the neonatal ICU. The KATH neonatal unit serves not only the Ashanti region but ten (10) out of 16 other Regions in Ghana.

For each time point, more than 50% of patients on admission were on at least one antimicrobial, even though the percentage was lower in 2019 (58.4%) compared to 2015 (64.0%). A similar trend was found in a study in the Ho Teaching Hospital in Ghana, where the prevalence of patients on at least one antimicrobial had reduced from 66.7% in July 2019 to 54.9% in January 2020, which they attributed to the introduction of antimicrobial stewardship interventions within the six months (9). Over the four years in our study, AMS interventions were not introduced. We estimate that the difference in the supply of ward specialities over time partly contributed to the different overall antimicrobial use prevalence in KATH.

TABLE 4 | Overview antibacterials for systemic use (J01) prescribed by chemical subgroup (ATC4) and the WHO AWaRe classification in 2015 and 2019.

ATC4	Antibiotics name (J01)	AwaReclass	2015N (%)	2019N (%)
Tetracyclines	Doxycycline	Access	1 (0.3)	2 (0.4)
Penicillins with extended-spectrum	Amoxicillin	Access	39 (11.3)	32 (5.8)
	Piperacillin	Watch	0 (0.0)	2 (0.4)
Beta-lactamase sensitive penicillins	Benzylpenicillin	Access	1 (0.3)	4 ((0.7)
	Penicillin V	Access	3 (0.9)	0 (0.0)
	Phenoxymethylpenicillin	Access	0 (0.0)	1 (0.2)
Beta-lactamase resistant penicillins	Flucloxacillin	Access	2 (0.6)	1 (0.2)
Combined penicillin, including beta-lactamase inhibitors	Amoxicillin and enzyme inhibitor	Access	0 (0.0)	29 (5.2)
Second-generation cephalosporins	Cefuroxime	Watch	84 (24.3)	106 (19.1)
Third-generation cephalosporins	cefotaxime	Watch	3 (0.9)	17 (3.1)
	ceftriaxone	Watch	52 (15.1)	78 (14.1)
Carbapenems	Meropenem	Watch	1 (0.3)	3 (0.5)
Combined sulfonamides/trimethoprim	Sulfamethoxazole and Trimethoprim	Access	6 (1.7)	18 (3.2)
Macrolides	Azithromycin	Watch	13 (3.8)	23 (4.1)
	Clarithromycin	Watch	1 (0.3)	1 (0.2)
	erythromycin	Watch	2 (0.6)	3 (0.5)
Lincosamides	Clindamycin	Access	27 (7.8)	33 (5.9)
Other aminoglycosides	Amikacin	Access	1 (0.3)	9 (1.6)
	gentamycin	Access	16 (4.6)	46 (8.3)
Fluoroquinolones	Ciprofloxacin	Watch	27 (7.8)	55 (9.9)
	levofloxacin	Watch	1 (0.3)	5 (0.9)
Combination of antibacterials	Penicillin, combinations	NR	1 (0.3)	0 (0.0)
Glycopeptides antibacterials	Vancomycin	Watch	0 (0.0)	1 (0.2)
Imidazole derivatives	Metronidazole	Access	64 (18.6)	84 (15.1)
Nitrofuran derivatives	Nitrofurantoin	Access	0 (0.0)	2 (0.4)
		Total	345	555

TABLE 5 | Comparing Quality indicators for antimicrobial prescriptions during the 2015 and 2019 surveys.

	KATH 2015n/N (%)	KATH 2019n/N (%)
Reasons for given antibiotics or changes in antimicrobials recorded in patients' notes*	301/426 (70.7)	530/630 (84.1)
Stop order/review date documented	356/426 (83.6)	624/630 (99.0)
Empiric antimicrobials prescribed	356/426 (85.4)	619/630 (98.3)
Parenteral antimicrobials administered	238/426 (55.9)	444/630 (70.5)
Healthcare-Associated Infection**	24/386 (6.2)	30/630 (4.8)
Use of biomarkers in supporting diagnosis***	12/247 (4.9)	28/368 (7.6)

n=sub-group contributions; N=total number of antimicrobials prescribed; %=percentages;
**denominator=N antimicrobials prescribed on the day of the PPS; **N patients with at least one HAI/N admitted patients on the day of the PPS; ***calculated at patient level with denominator=N patients on at least one antimicrobial on the day of the PPS.*

The neonatal unit had the highest antimicrobial usage because of the unit's high referrals of critically ill patients. On the other hand, we saw a halving of antimicrobial use (AMU) prevalence among women admitted for obstetric reasons (from 100% in 2015 to 54.3% in 2019). Unlike neonatal units exclusively found only at KATH, many hospitals (public and public) are dotted all over the region with expertise in managing obstetric cases.

The most prescribed antibacterials for systemic use over time were "other beta-lactams" cefuroxime and ceftriaxone. Our study over time showed similar results as compared to pooled results of a multi-centre study in Ghana at seven sentinel sites where the top-five antibiotics used consisted of metronidazole (20.6%), cefuroxime (12.9%), ceftriaxone (11.8%), amoxicillin/clavulanic acid (8.8%) and ciprofloxacin (7.8%). This study consisted of 4 teaching hospitals (including the current study site), two regional Hospitals, and one district hospital (10). In another study done in 2019 in 3 district hospitals in the same region as this tertiary facility, antibiotic agents used included a strikingly higher use of amoxicillin (36.5%), penicillin with extended-spectrum belonging to the WHO Access class (beside ciprofloxacin (17.4%), ceftriaxone (11.3%), cefuroxime (9.6%) and ampicillin (7.8%) (11). In our study, amoxicillin use decreased considerably over time from 11.3% in 2015 to 5.8% in 2019. KATH serves as the only major referral hospital for district hospitals. Therefore, we expect to observe a more broad spectrum of antibiotics prescriptions compared to the referenced publications from district hospitals. The similarities in antimicrobial use may be attributed to KATH serving as a primary care facility for adjourning communities.

Among the medical conditions for which antibacterials were prescribed was pneumonia, followed by skin and soft tissue infections for the 2015 and 2019 surveys. Tuberculosis and HIV were significantly represented in the top ten medical conditions in 2019 compared to 2015. The availability and quality of antiretrovirals in 2019 were better than in 2015. HIV positive persons on antiretrovirals are considered stable individuals living with a chronic medical condition and subject to every environmental condition like HIV negative individuals. HIV positive patients have a significant risk of developing tuberculosis than non-HIV positives (12). This might explain why in 2019, both HIV and TB pooled up among the top ten.

There was an increase in two "Watch" medications on the World Health Organization (WHO) AWaRe classification between 2015 and 2019. Ceftriaxone and ciprofloxacin are "Watch" medications that have high resistance potential (13). Such antibiotics should therefore be selected guided by culture and sensitivity results. However, there was no documentation of positive bacterial growth on cultures in this study. No documentation on culture results might be due to the point prevalence study. The antibiotics prescription based on biomarkers increased from 4.9% in 2015 to 7.6% in 2019. In a multi-centre sentinel study in 2019, 5.2% of antibiotics prescriptions were based on biomarkers (10). The proportion is generally low supporting the use of antibiotics empirically than targeted. The survey results showed that the empiric treatment was 85.4% (356/426) in 2015. This had increased to 98.3% (619/630) in 2019. Antimicrobial stewardship is vital to highlight specimen collection for culture and sensitivity before issuing prescriptions.

There was an increase in parenteral use of antimicrobials from 55.9% in 2015 to 70.5% in 2019, which deserves a deeper investigation. In a National tertiary hospital in Nigeria, a Global PPS study found an increase in parenteral antimicrobials from 70% in 2015 to 82% in 2017 (14). Even though the exact reasons why parenteral antimicrobials increased in the institutions are not clear; both hospitals had not implemented antimicrobial stewardship programme.

There was a decrease in Healthcare-Associated infections (HAI) between the two-time points, from 6.2% in 2015 to 4.8% in 2019. In a multicenter study conducted in Ghana in 2016, the overall HAI prevalence was 8.2%, ranging from 3.5% to 14.4%, with higher proportions of infections in secondary and tertiary care facilities (15). The decrease in trend at KATH could be attributed to a robust infection control and prevention committee which proactively oversees the establishment of systems to control infection spread.

In conclusion, the trends in antimicrobial usage over the four years (2015-2019) remained high, with AMU prevalence over 50%. Encouraging was to observe the increase in the use of biomarkers. We hope to further increase the diagnostic capacity in future and also move towards the possibility of antimicrobial susceptibility testing. The inauguration of the antimicrobial stewardship committee in July 2021 at KATH has been mandated to improve clinical outcomes, optimise patient safety, reduce antimicrobial resistance, and reduce cost by reducing hospital stay through strategic stewardship activities such as stewardship rounds and monitoring of quality indicators for antimicrobial use. After implementing the AMS interventions in February 2022, a new PPS will be performed to investigate the effectiveness of imposed interventions and define adjustments as needed.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Komfo Anokye Teaching Hospital Institutional review board. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

AE, DA, IP, HG and AV developed the concept and contributed to the manuscript write-up. MY, KA, and NM collected the data and contributed to the manuscript write-up. All authors read through and accepted the final version of the manuscript.

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